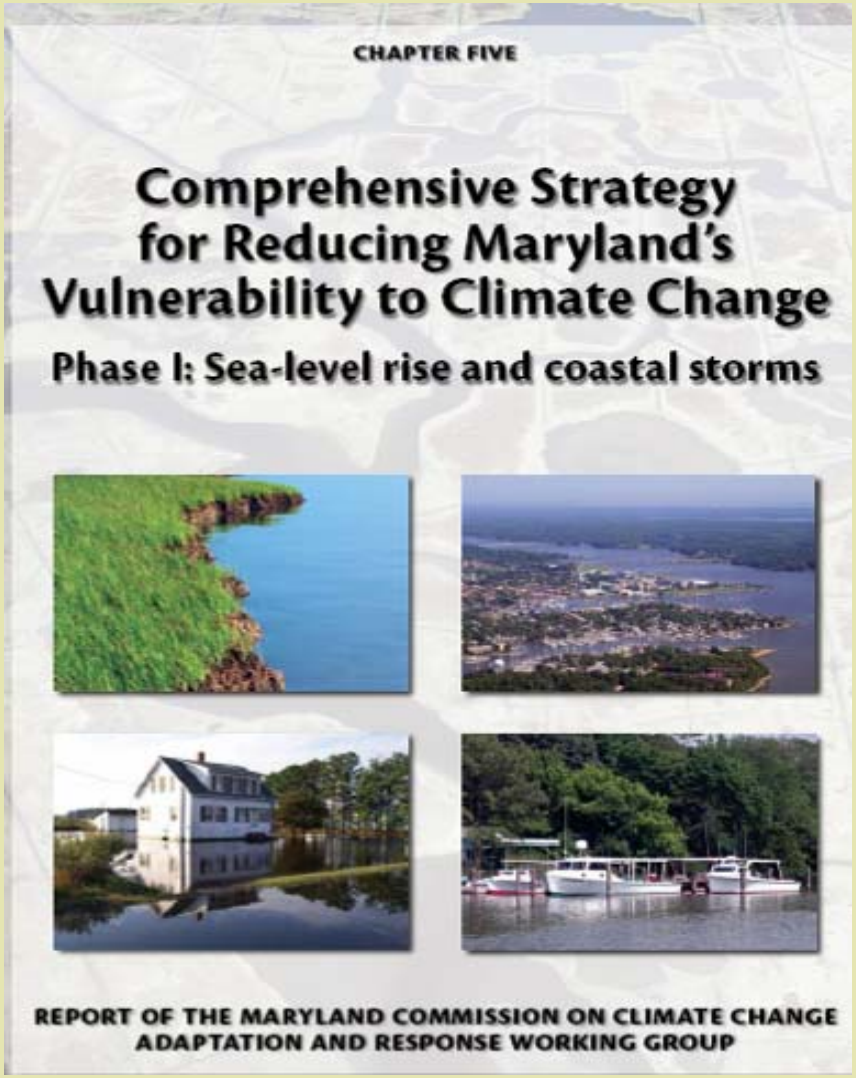
Maryland Coast Sea Level Rise

- **Maryland DNR and other sources are predicting a rise in sea level, leading to more frequent floods and higher storm surges in coastal areas.**
- **This trend would be a continuation of the one-foot rise in sea level along the Maryland coast during the past century.**
- **Sources reviewed for this study:**
  - *Sea Level Rise Studies, City Dock and Eastport Areas, WBCM, 2010*
  - *Climate Action Plan, State of Maryland 2008*
  - *Final Flood Damage Reduction Analysis for the United States Naval Academy, 2006, U.S. Army Corps of Engineers*

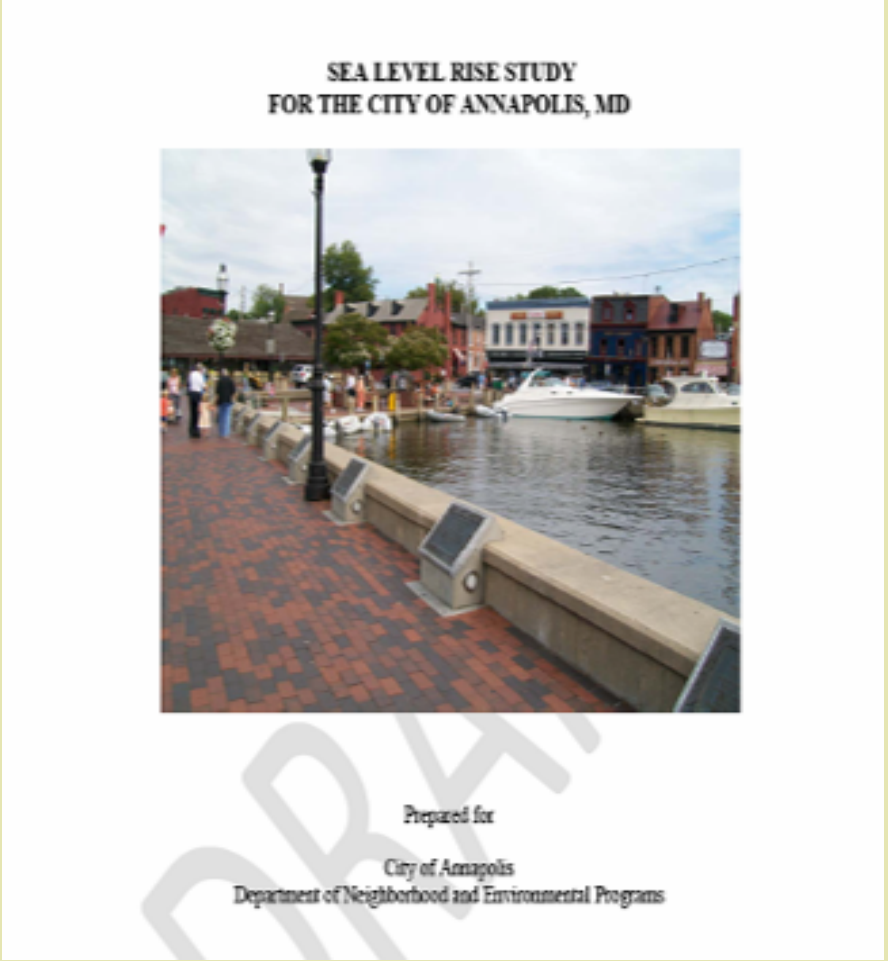
Climate Action Plan (State of Maryland 2008)

- **Chapter 5 of Maryland's Climate Action Plan uses global sea-level rise projections, along with regional land subsidence data**
- **Predicts sea level rise along Maryland's coast:**
  - Between 0.6 feet and 1.3 feet by 2050
  - 2.7 to 3.4 feet by the end of the century
- **Recommends that coastal communities prepare for increased flooding.**



Sea Level Rise Studies: City Dock & Eastport 2010, 2011

- **Used NOAA data specific to Annapolis collected daily since 1996.**
- **The trend indicates a rise in the mean sea level of 0.5 feet by 2050.**
- **Current FEMA 100-year floodplain is at 7.8 feet.**
- **In 2050, areas at elevation 8.3 feet or below would be in the 100-year floodplain.**



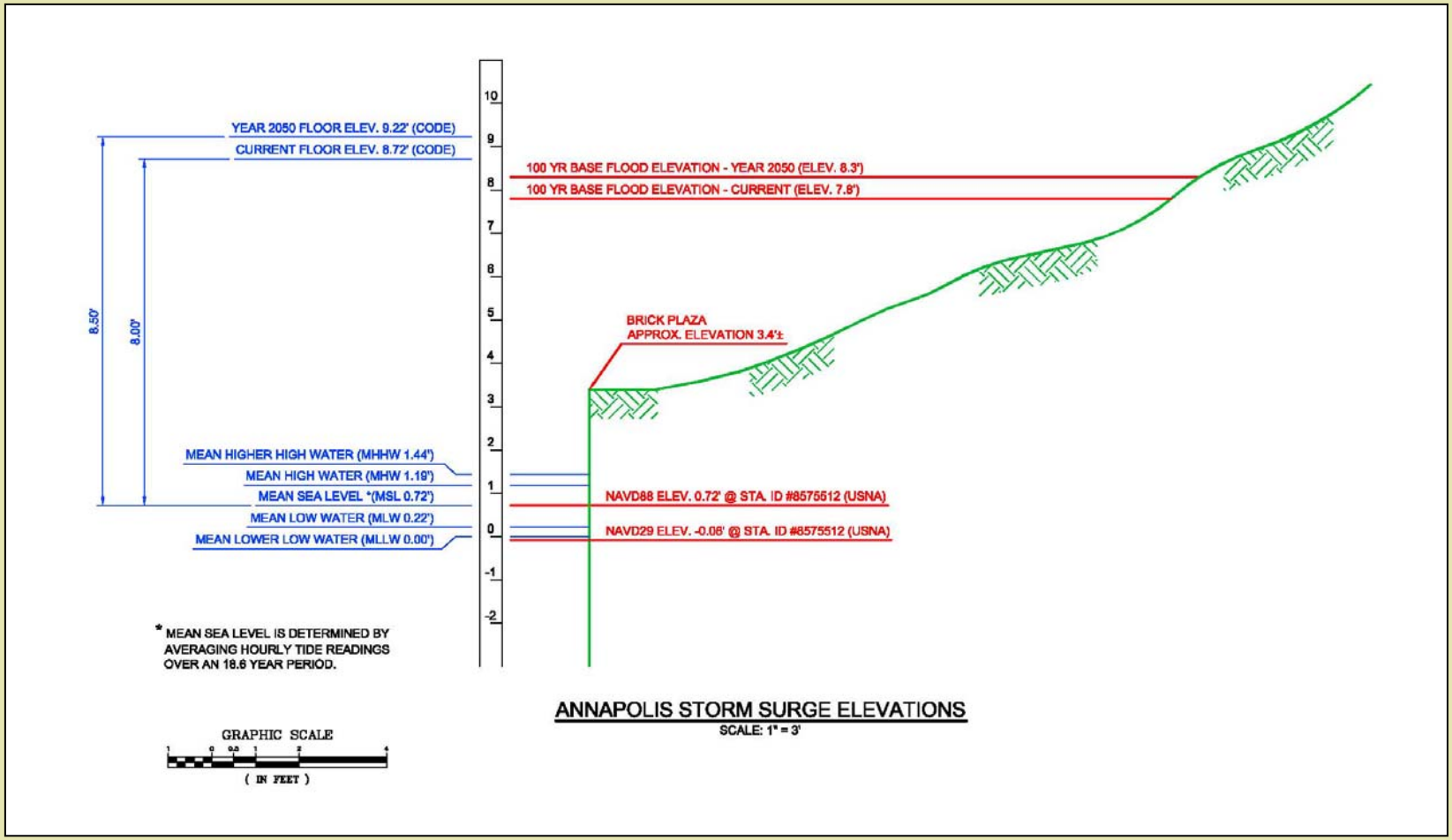
Final Flood Damage Reduction Analysis for U.S. Naval Academy, 2006

- **Prepared by U. S. Army Corps of Engineers following damage from Hurricane Isabel**
- **Naval Academy bases its flood protection measures on the FEMA 500-year flood, which has an elevation of 9.98 feet.**

Recommendations in this report:

- **Are based upon WBCM's projected sea level rise of 0.5 feet by 2050**
- **This projection is based on trends derived from local, daily, tides data over the past 16 years.**
- **The City will need to monitor data and projections and adjust it's approaches regulations if needed.**

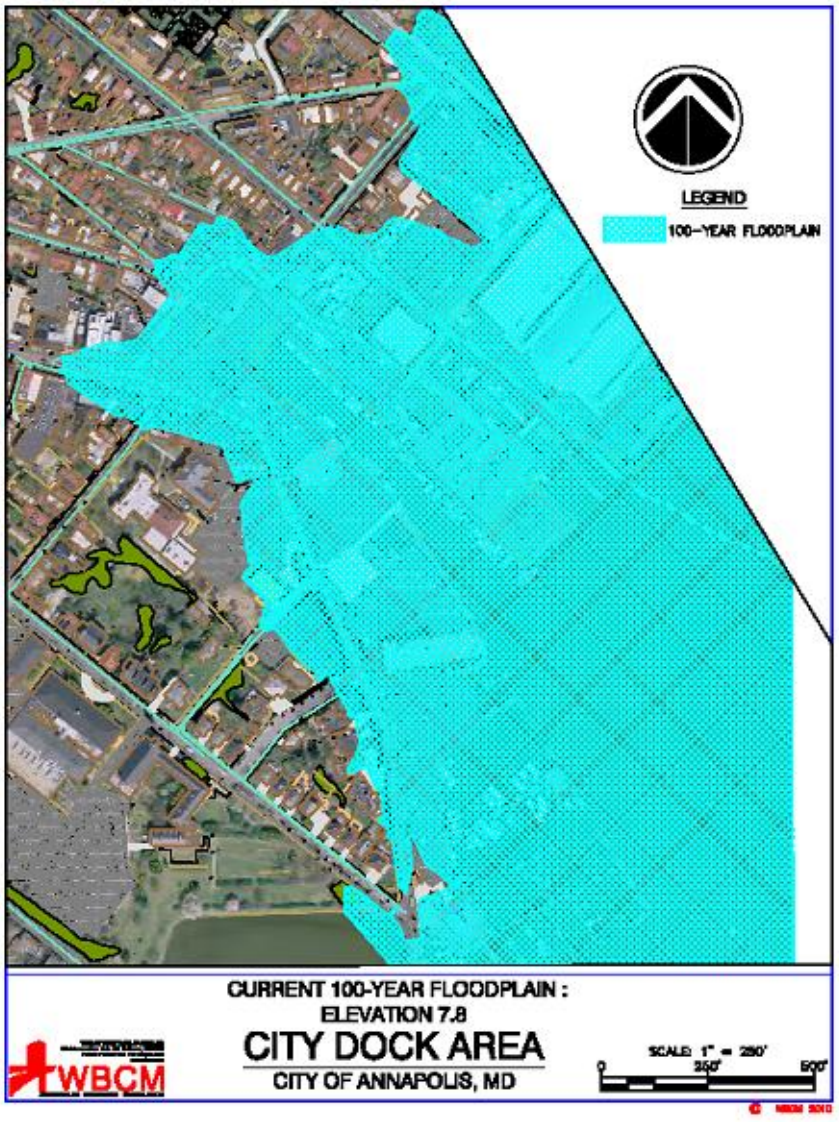
Annapolis Storm Surge Elevations

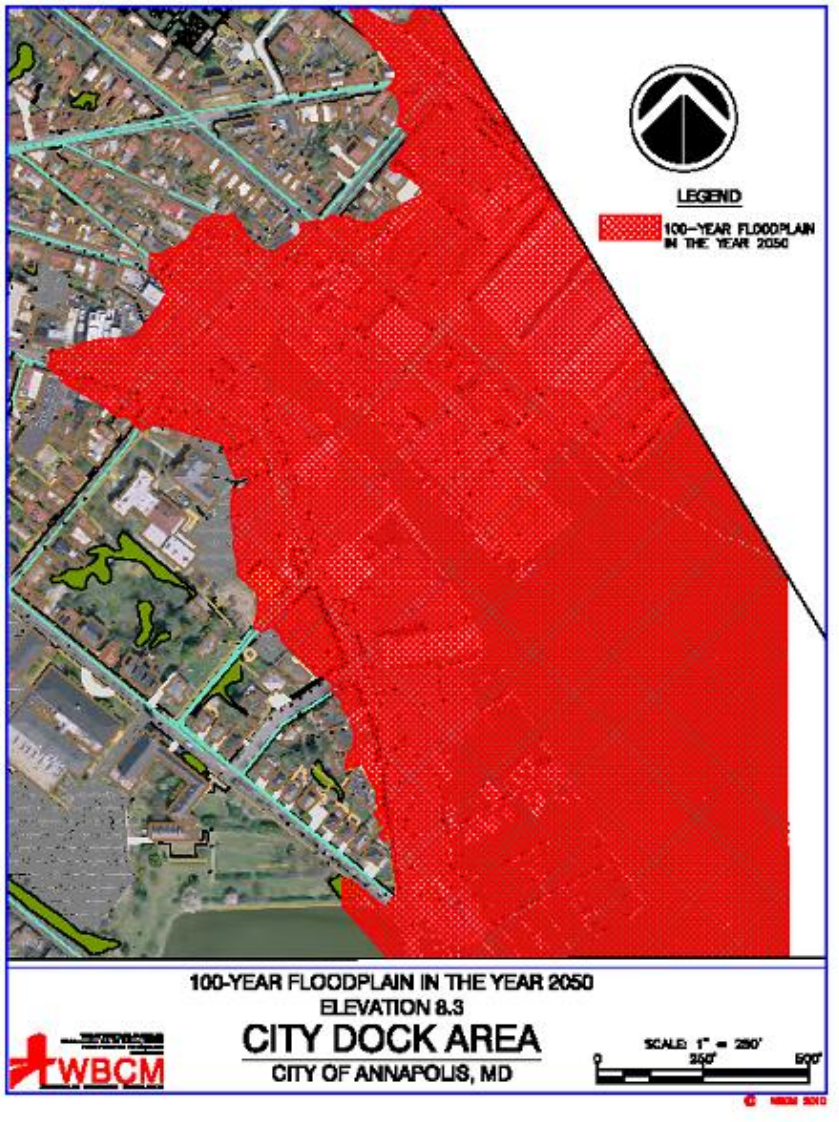


Left side: Sea level elevations and code requirements in NGVD 1929 datum

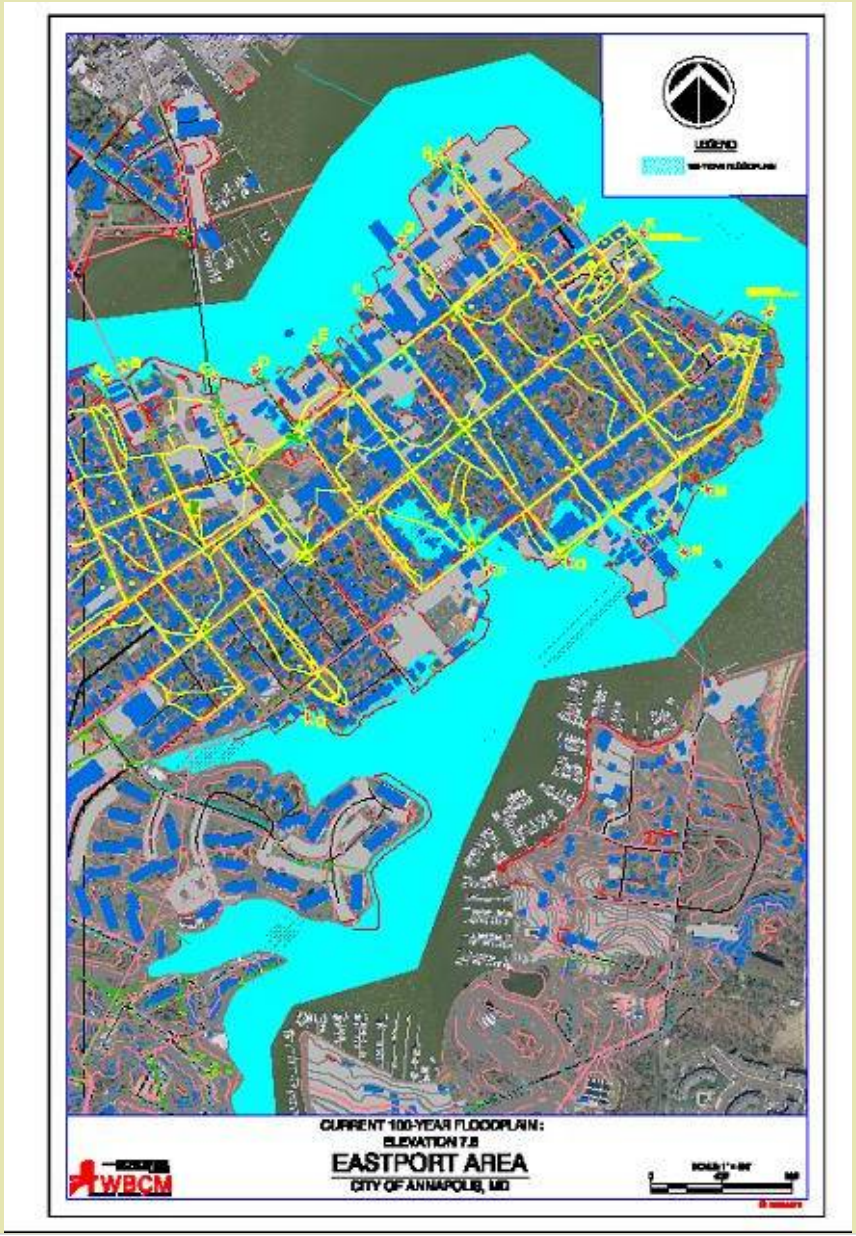
Right side: Sea level and floodplain elevations in NAVD 1988 datum

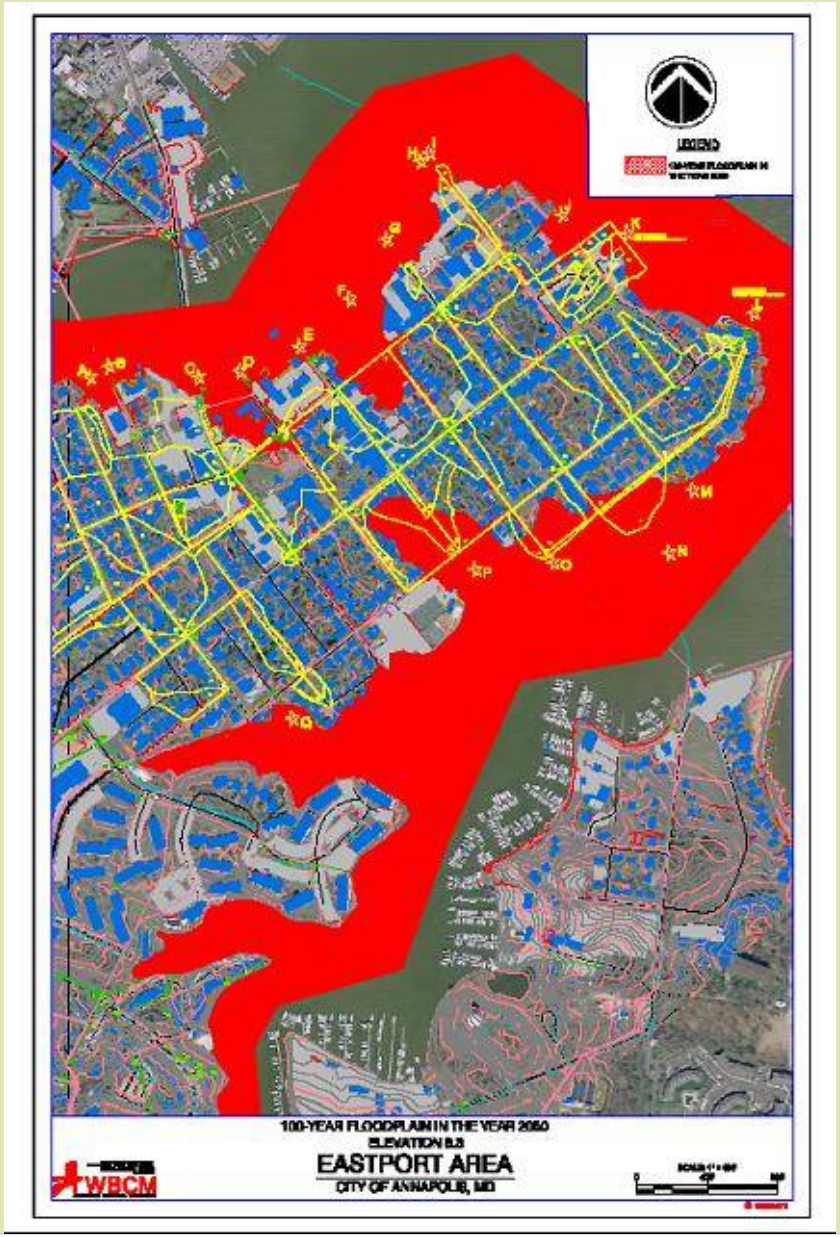
City Dock Area Floodplain 2010 & 2050





Eastport Floodplain 2010 & 2050





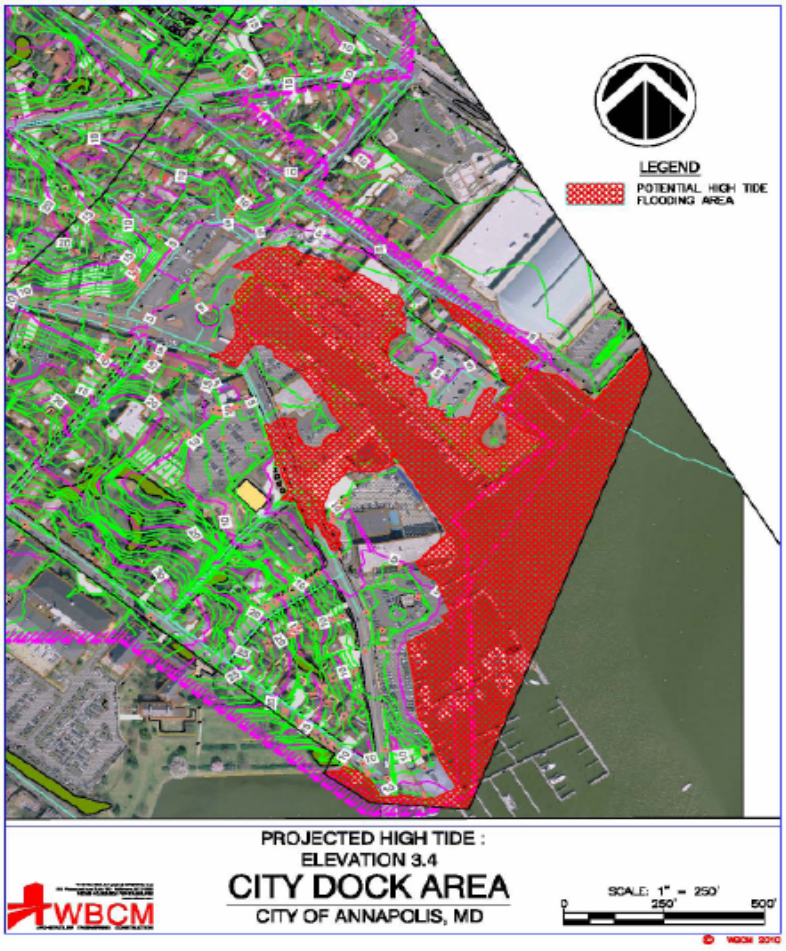


FIGURE 4-3: PROJECTED HIGHEST LUNAR TIDE FLOODPLAIN IN THE YEAR 2050

Potential Impacts of Sea Level Rise – Location Dependent

- **Shore erosion**
- **Inundation (**gradual submergence of land areas**)**
- **Coastal flooding - greater frequency and severity**
- **Higher water tables and salt water intrusion**

Coastal flooding is the major concern for Annapolis.

From WBCM's 2010 study of the City Dock Area:

"Minor nuisance flooding around the City Dock (currently) begins to occur when tides rise above elevation 1.9 feet. At that level, water begins to flow out of the existing storm drain system even during sunny days. Projecting to the year 2050, the occurrence of nuisance flooding is expected to more than double. "

Response to Increased Flooding

- **Annapolis' response to flooding should focus on protection and preservation (not abandonment, retreat)**
  - Protection of existing buildings and infrastructure
  - Preservation of historic structures
  - Preservation of the maritime industry and dock infrastructure

Recommended City Code Revisions

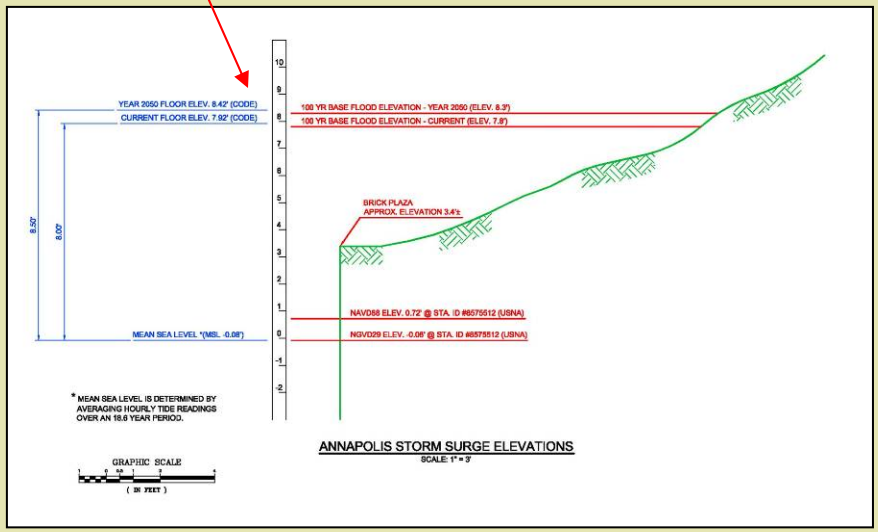
- **Recommended revisions are primarily for the Floodplain Ordinance and the Zoning Ordinance.**
- **Many other sections of the code were reviewed; no other revisions are recommended.**
- **Reports for several other local jurisdictions have resulted in similar recommendations**
  - Depending on location and circumstances some recommend retreat

Current Floodplain Ordinance

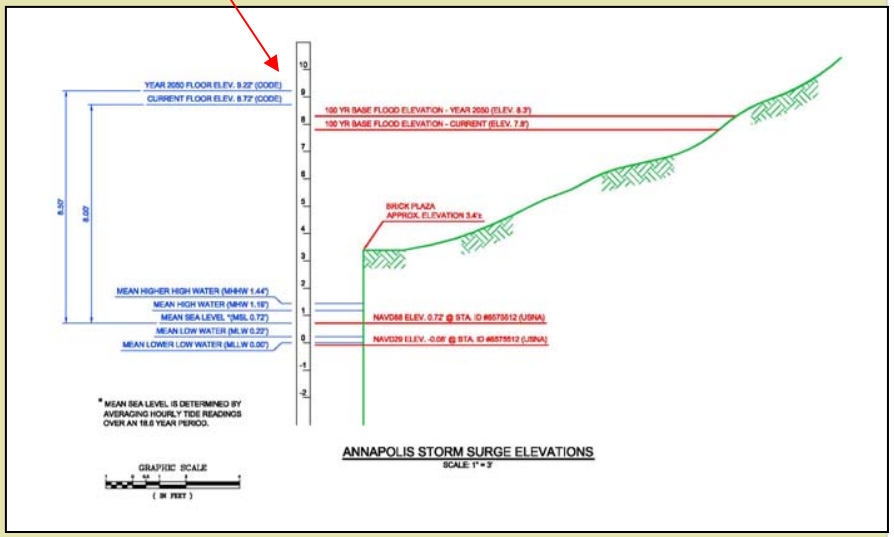
- **Regulates properties shown on FEMA Flood Insurance Rate Maps.**
- **The first floor of new structures must be at least 8 feet above mean sea level.**
- **For nonresidential structures, may allow flood-proofing rather than elevation of the first floor.**

Floodplain Ordinance: Recommended Revisions

- **Update definitions for base flood elevation, elevation certificate and mean sea level.**
  - Where elevations are measured from
  - Determines 1st floor heights



NGVD 1929 datum

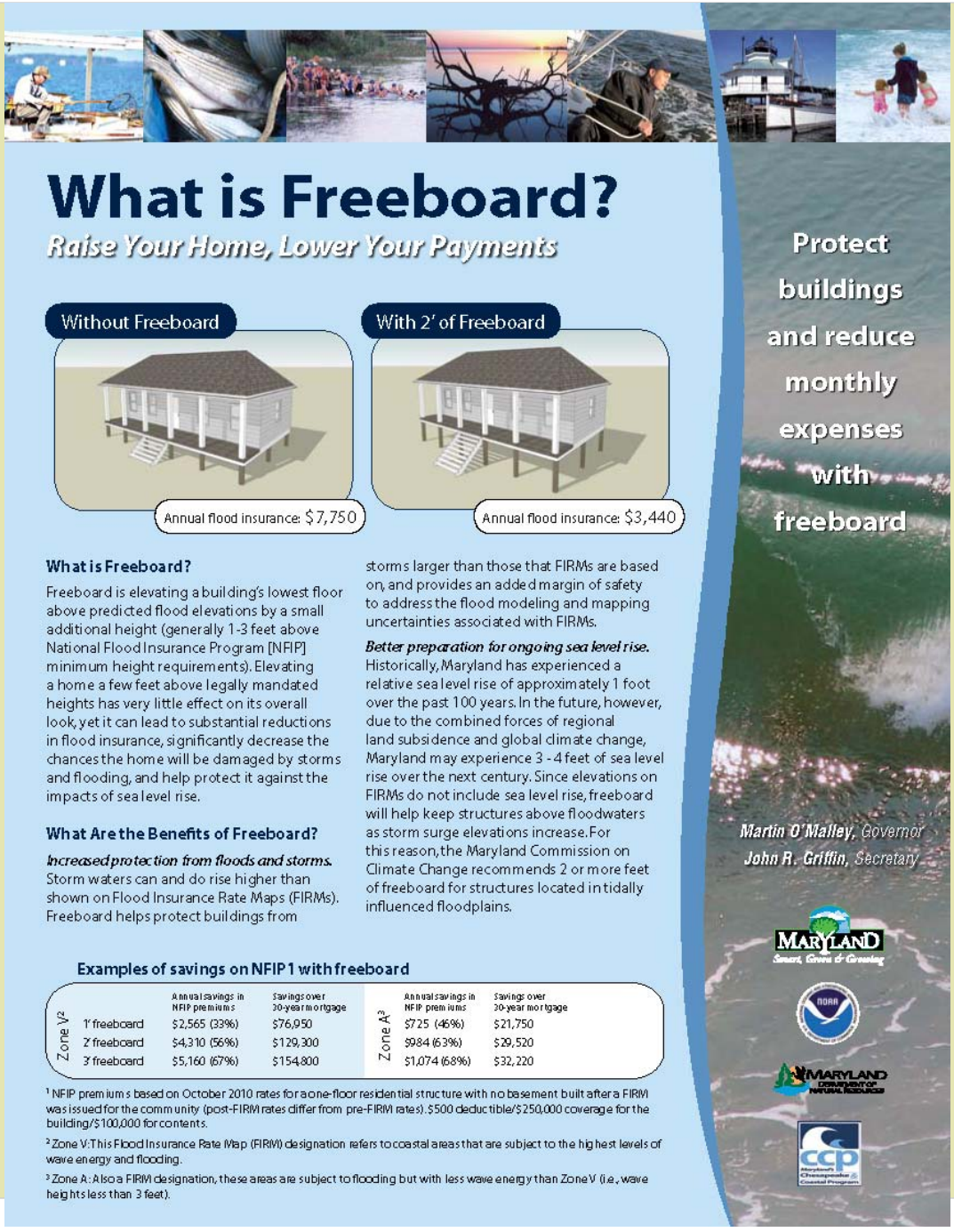


NAVD 88 datum

Floodplain Ordinance: Recommended Revisions

- **Add a "freeboard" requirement – an additional height requirement above the base flood elevation.**
  - "Freeboard" compensates for factors that could contribute to flood heights greater than expected, such as waves, impervious surfaces, and increased storm surges.
  - Makes the structure eligible for a lower flood insurance rate.
  - FEMA encourages communities to adopt at least a one-foot freeboard
  - Maryland Climate Change Plan recommends a minimum 2 -foot freeboard above the 100-year flood level for coastal communities

Portion of DNR publication on freeboard



What is Freeboard?

Raise Your Home, Lower Your Payments

Without Freeboard

Annual flood insurance: $7,750

With 2' of Freeboard

Annual flood insurance: $3,440

What is Freeboard?

Freeboard is elevating a building's lowest floor above predicted flood elevations by a small additional height (generally 1-3 feet above National Flood Insurance Program [NFIP] minimum height requirements). Elevating a home a few feet above legally mandated heights has very little effect on its overall look, yet it can lead to substantial reductions in flood insurance, significantly decrease the chances the home will be damaged by storms and flooding, and help protect it against the impacts of sea level rise.

What Are the Benefits of Freeboard?

Increased protection from floods and storms. Storm waters can and do rise higher than shown on Flood Insurance Rate Maps (FIRMs). Freeboard helps protect buildings from storms larger than those that FIRMs are based on, and provides an added margin of safety to address the flood modeling and mapping uncertainties associated with FIRMs.

Better preparation for ongoing sea level rise. Historically, Maryland has experienced a relative sea level rise of approximately 1 foot over the past 100 years. In the future, however, due to the combined forces of regional land subsidence and global climate change, Maryland may experience 3 - 4 feet of sea level rise over the next century. Since elevations on FIRMs do not include sea level rise, freeboard will help keep structures above floodwaters as storm surge elevations increase. For this reason, the Maryland Commission on Climate Change recommends 2 or more feet of freeboard for structures located in tidally influenced floodplains.

Examples of savings on NFIP[1] with freeboard

		Annual savings in NFIP premiums	Savings over 30-year mortgage		Annual savings in NFIP premiums	Savings over 30-year mortgage
Zone V[2]	1' freeboard	$2,565 (33%)	$76,950	Zone A[3]	$725 (46%)	$21,750
	2' freeboard	$4,310 (56%)	$129,300		$984 (63%)	$29,520
	3' freeboard	$5,160 (67%)	$154,800		$1,074 (68%)	$32,220

[1] NFIP premiums based on October 2010 rates for a one-floor residential structure with no basement built after a FIRM was issued for the community (post-FIRM rates differ from pre-FIRM rates). $500 deductible/$250,000 coverage for the building/$100,000 for contents.

[2] Zone V: This Flood Insurance Rate Map (FIRM) designation refers to coastal areas that are subject to the highest levels of wave energy and flooding.

[3] Zone A: Also a FIRM designation, these areas are subject to flooding but with less wave energy than Zone V (i.e., wave heights less than 3 feet).

Protect buildings and reduce monthly expenses with freeboard

Martin O'Malley, Governor
John R. Griffin, Secretary

MARYLAND
Smart, Green & Growing

NOAA

MARYLAND DEPARTMENT OF NATURAL RESOURCES

ccp Maryland Chesapeake & Coastal Program

Zoning Ordinance: Recommended Revisions

- **Historic District**
  - Provide a process for emergency repairs following flooding, fire or other disaster.
  - Address storm protection measures that could be installed by property owners, such as temporary or permanent flood walls.

Middleton Tavern: protection for minor flooding – wall to protect exterior furnishings and raised floor height.

Zoning Ordinance: Recommended Revisions

- **Create a "Coastal Floodplain Overlay Zone"**
- **Purpose:**
  - To require flood protection standards in areas not shown on FEMA floodplain maps.
  - To require more stringent flood protection measures for areas subject to coastal flooding with wave action.

Proposed Coastal Floodplain Overlay Zone

- **Include the current 100-year floodplain in the areas of Annapolis affected by coastal tides**
- **Also include coastal areas projected to be within the base floodplain by 2050, using a projected 8.3-foot floodplain elevation**
- **Apply the minimum elevation and floodproofing standards of the Floodplain Ordinance**
- **Evaluate wave action in Annapolis' tidal floodplain areas.**
  - FEMA recommends more stringent construction standards in coastal areas subject to greater hazards due to wave action (the FEMA "VE" zone standards).

Title 15, Harbors and Waterfront Areas Recommended Revisions

- **Bulkheads and piers are installed at varying heights. There are no standards.**
- **Provide for protection during storms by requiring that the top of bulkheads and piers generally have a minimum elevation of 8.3 feet. Allow flexibility where this elevation is not feasible.**

Other Responses to Flooding

- **Code revisions apply to property owners**
- **Other components of flood protection would be implemented by the City (some would be expensive):**
  - Public flood protection projects
  - Improvements to infrastructure
  - Education and management
  - Ongoing planning

Subdivision Ordinance

Culverts, Storm Drains, and Drainage Structures

- **During coastal flood events, water in storm drains can be forced backwards, flooding areas that they are intended to drain.**
- **Require that for storm drains within the current or projected 100-year floodplain, backflow preventers be installed.**

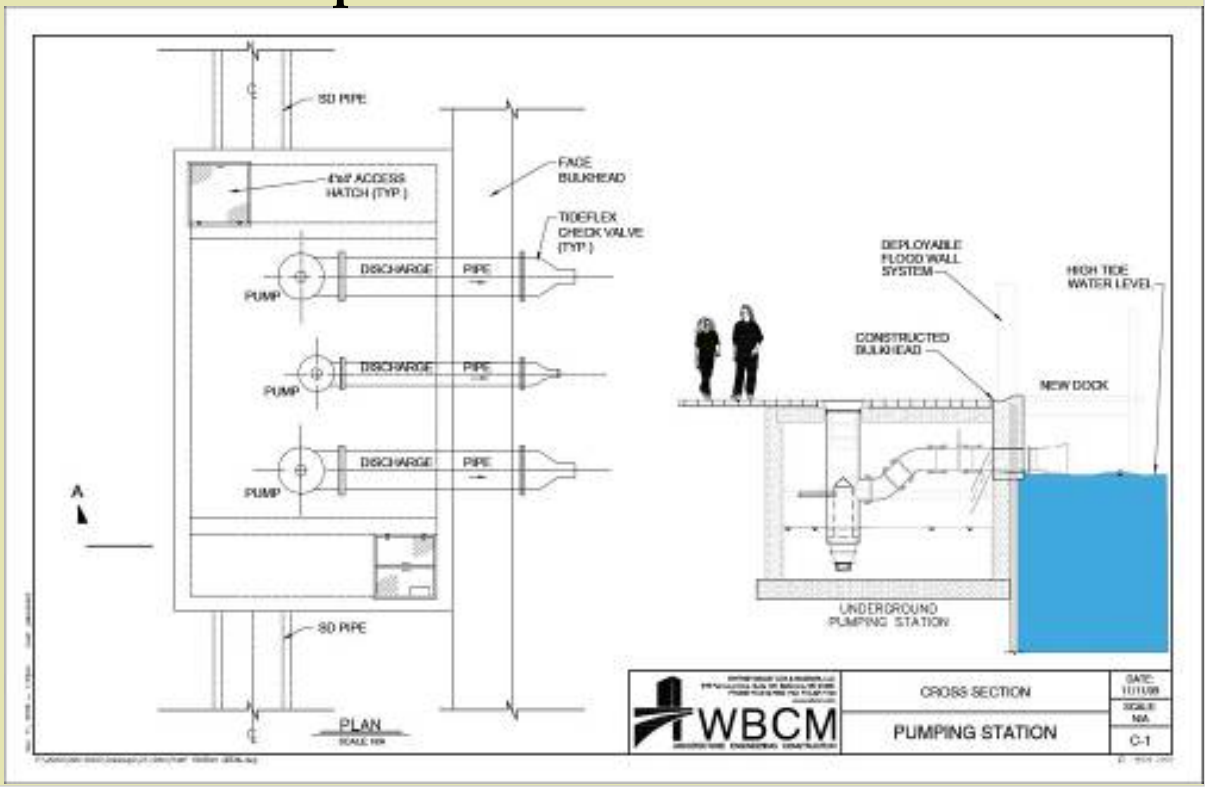
Public Flood Protection Projects

- **WBCM's studies found three types of public flood protection projects most relevant for Annapolis:**
  - Temporary flood walls
  - Backflow preventers on the city storm drain outflows
  - Temporary dams such as portable coffer dams

FIGURE 5-8: POTENTIAL FLOODING BEHIND FLOOD WALLS

Improvements to Infrastructure

- Storm drain improvements
- Road improvements: changing elevation and slope; providing more durable base materials
- Flood-proofing city utilities
- Moving city facilities out of flood-prone areas

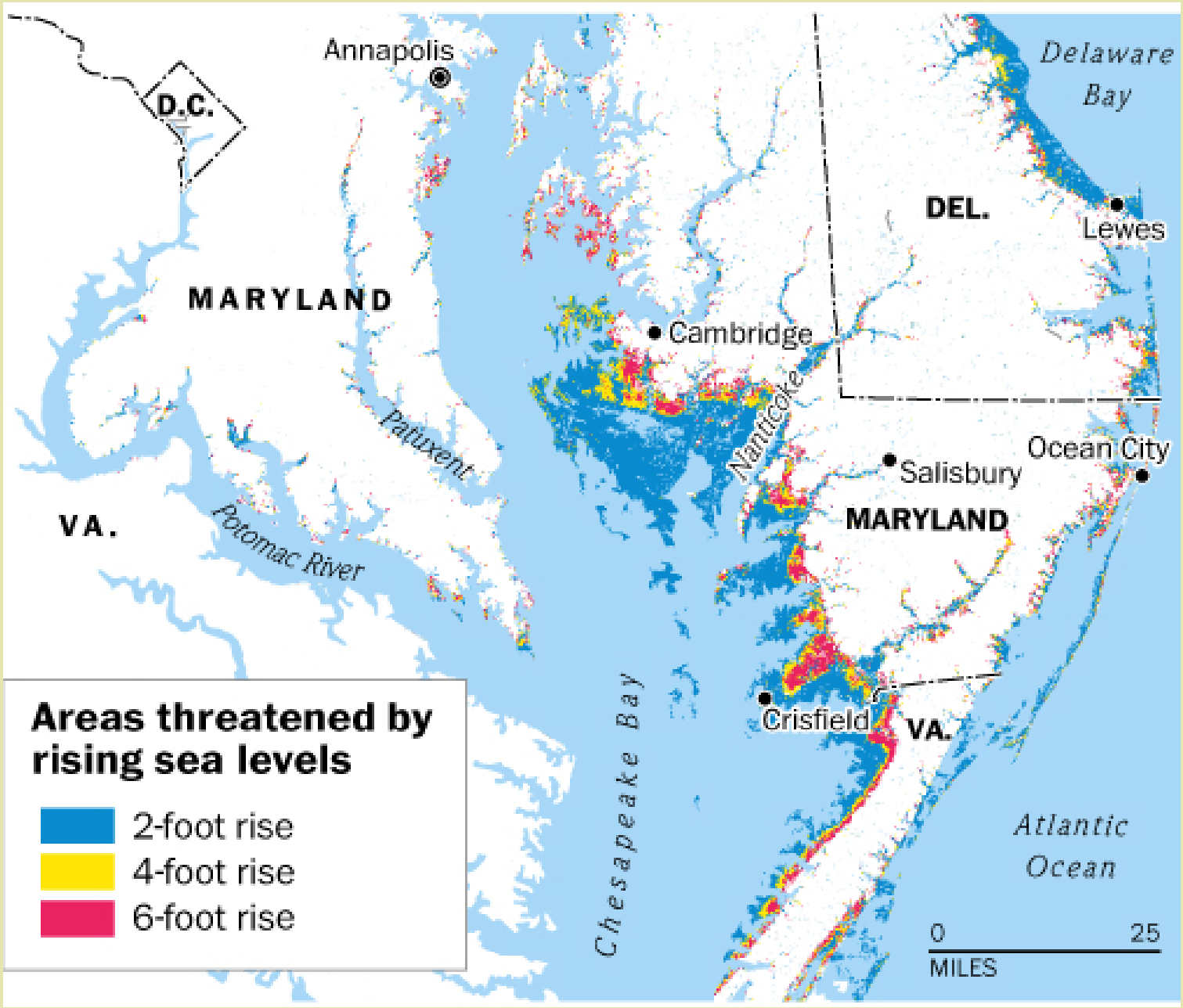


Education and Management

- Mapping streets frequently affected by flooding;
- Establishing evacuation routes;
- Planning emergency shelters;
- Providing educational materials;
- Mapping operations that store hazardous materials

Ongoing Planning

- Review current and projected sea levels on the same cycle as the city's comprehensive plan (about every 6 years).
- Evaluate options for protecting historic structures and waterfront areas.
- Identify public utility structures and equipment that may be endangered by floods.
- Review needs for drainage and road improvements.
- Revisit the code sections reviewed in this report.


Annapolis
D.C.
MARYLAND
VA.
Patuxent
Potomac River
Chesapeake Bay
Cambridge
Nanticoke
Salisbury
MARYLAND
Crisfield
VA.
Delaware Bay
DEL.
Lewes
Ocean City
Atlantic Ocean
0
25
MILES
Areas threatened by rising sea levels
2-foot rise
4-foot rise
6-foot rise